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ERICKSON ARENA WOOD-BURNING FURNACE

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MANITOBA/CANADA CONSERVATION AND RENEWABLE ENERGY DEMONSTRATION AGREEMENT

The availability of secure and affordable energy supplies is a subject of national concern. It is an accepted fact that our primary energy sources — oil and natural gas — are becoming less accessible and more costly. However, Canada is well-endowed with renewable and alternative resources that can provide a bridge into the future.

To this end, the governments of Manitoba and Canada entered into a Conservation and Renewable Energy Demonstration Agreement which was signed May 9, 1980 and terminated March 31, 1984. The Agreement was dedicated to the development and demonstration of conservation and renewable energy technologies. Equally cost-shared by the provincial and federal governments, the program had a total budget of $18-million.

The objectives of CREDA are:

- To develop and demonstrate promising new technologies, which, when widely adopted, will exploit renewable resources, conserve energy and/or use energy more efficiently.
- To develop broad public awareness of the potential of renewable energy and conservation technology.
- To provide opportunities for the commercial application of the technologies within Manitoba.
- To create economic spin-off benefits for manufacturing, industry and commerce.
- To create employment in new or existing energy-related industries.

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EXECUTIVE SUMMARY

Erickson Arena, a new recreation facility located in Erickson, Manitoba, received funding under the Manitoba/Canada Conservation and Renewable Energy Demonstration Agreement (CREDA) to install a wood-burning furnace as the Arena's main heat source.

Intract Consultants of Winnipeg was engaged to monitor and evaluate the project.

The objective of this installation is to demonstrate and verify the viability and energy cost savings possible in using a renewable natural resource (wood) in rural areas as an alternative energy source.

The project was completed in March, 1985, and data verification and analysis followed. The analysis showed that the wood-burning furnace is adequate to supply all the heat required in the heated area of about 15m x 30m x 5.5m high, except on extremely cold days. In an average year, the savings in electricity should be approximately $2 700, based on 3.886 cents/kwh. (Manitoba Hydro April 1985 rate, 6% provincial sales tax included).

The capital cost of the wood-burning furnace was $18 400. This includes labour and material of the stove, the chimney and associated ductwork. The simple payback period for this installation is approximately 6.8 years. The total fuel cost savings over an assumed 20-year life of the wood-burning furnace are estimated to be $54 000, assuming the cost of electricity will escalate at the same rate as inflation.

The main disadvantage of a wood-burning furnace is its labour intensive operation. The stove has to be fed with wood manually. Inspection of the chimney and maintenance of the furnace must be performed regularly.

This project has demonstrated that wood-burning furnaces are viable, especially in rural areas, where:

1. Plentiful supply of wood is available at little or no cost.
2. Manpower is available, at no cost, to operate and maintain the furnace.
3. The building is at a remote location where the cost of electricity or oil is high.

RÉSUMÉ ADMINISTRATIF

La patinoire d'Erickson est un nouvel établissement récréatif qui est situé à Erickson (Manitoba) et dont la source principale de chauffage - une chaudière à bois - a été financée en commun par le Canada et le Manitoba en vertu de l'entente fédérale-provinciale de démonstration des énergies renouvelables et des économies d'énergie (D.E.R.E.E.).

La compagnie "Intract Consultants" de Winnipeg fut engagée pour surveiller et évaluer le projet.

Il s'agissait de démontrer et de vérifier que ce projet était rentable et qu'il était possible d'économiser sur le coût de l'énergie en utilisant, dans les milieux ruraux, des ressources naturelles renouvelables (du bois) comme source d'énergie.

Terminée en mars 1985, l'installation fut suivie d'une vérification des données et d'une analyse. Celle-ci fit ressortir que la chaudière à bois suffisait à produire toute la chaleur requise dans la pièce chauffée mesurant environ 15m x 30m x 5,5m de haut, sauf lorsqu'il faisait excessivement froid. En prenant 3,886 cents comme prix de base du kilowatt-heure (tarif de Hydro Manitoba en vigueur en avril 1985 et comprenant la taxe de vente provinciale de 6%), une économie en électricité d'environ 2 700 dollars serait réalisée dans une année moyenne.

Les frais de premier établissement de la chaudière à bois se sont élevés à 18 400$, y compris la main d'oeuvre, le matériel, la cheminée et les conduites d'air. La période de récupération simple est d'environ 6,8 années. En supposant que le prix de l'électricité augmente dans la même proportion que l'inflation et en estimant à 20 ans la durée de vie de la chaudière à bois, on a calculé que l'économie totale en énergie serait de 54 000 dollars.

L'inconvénient majeur de la chaudière à bois est l'importance du travail manuel que son fonctionnement nécessite. Elle doit être alimentée à la main et faire l'objet d'un entretien régulier. La cheminée doit aussi être inspectée à intervalles réguliers.

Ce projet a démontré que les chaudières à bois sont rentables, notamment dans les régions rurales remplissant les conditions suivantes :

1. Source abondante de bois qui ne coûte rien ou presque rien.
2. Main-d'oeuvre bénévole disponible pour alimenter et entretenir la chaudière.
3. Bâtiment situé dans une localité éloignée où le prix de l'électricité ou du mazout est élevé.

INTRODUCTION

Erickson and District Skating Arena is a newly constructed recreational facility located in Erickson, Manitoba.

During the planning phase of this Arena, in mid-1983, its building committee applied to the Manitoba Department of Energy & Mines for funding under the Manitoba/Canada Conservation and Renewable Energy Demonstration Agreement (CREDA) Program to install a wood-burning furnace as the Arena's main heat source. Subsequently, funding was approved and the installation was completed in March, 1985.

Intract Consultants, a Winnipeg engineering consulting firm, was engaged to monitor and evaluate the project.

The objective of this installation is to demonstrate and verify the viability and energy cost savings possible in using a renewable natural resource (wood) in rural areas as an alternative energy source.

DESCRIPTION OF ARENA

The Erickson Arena is a new facility established by the community of Erickson, including the Rural Municipality of Clanwilliam, Rolling River Indian Reserve, and the Village of Erickson, together with local community organizations and volunteers.

Referring to Fig. 1 & 2 and Photo 1, the Erickson Arena is approximately 30m wide, 75m long, and 5.5m high. It's rink area is about 30m wide by 60m long, capable of accommodating around 200 people. The remainder of the arena which is about 30m wide by 15m long, has two levels. The ground level which has a heated area of 450 square metres, is used for an office, lunch room, locker and change rooms. The mezzanine level with a heated area of 110 square metres provides additional space for other uses.

Mechanical cooling is not used in this Arena. In the winter, cold outdoor air is brought in to cool the ice surface in the rink. There is no heating in the rink area. The heating system for the observation area is described in the next section.

FIG. I. PLAN VIEW OF ARENA WOODSTOVE HEATING SYSTEM ON MAIN FLOOR

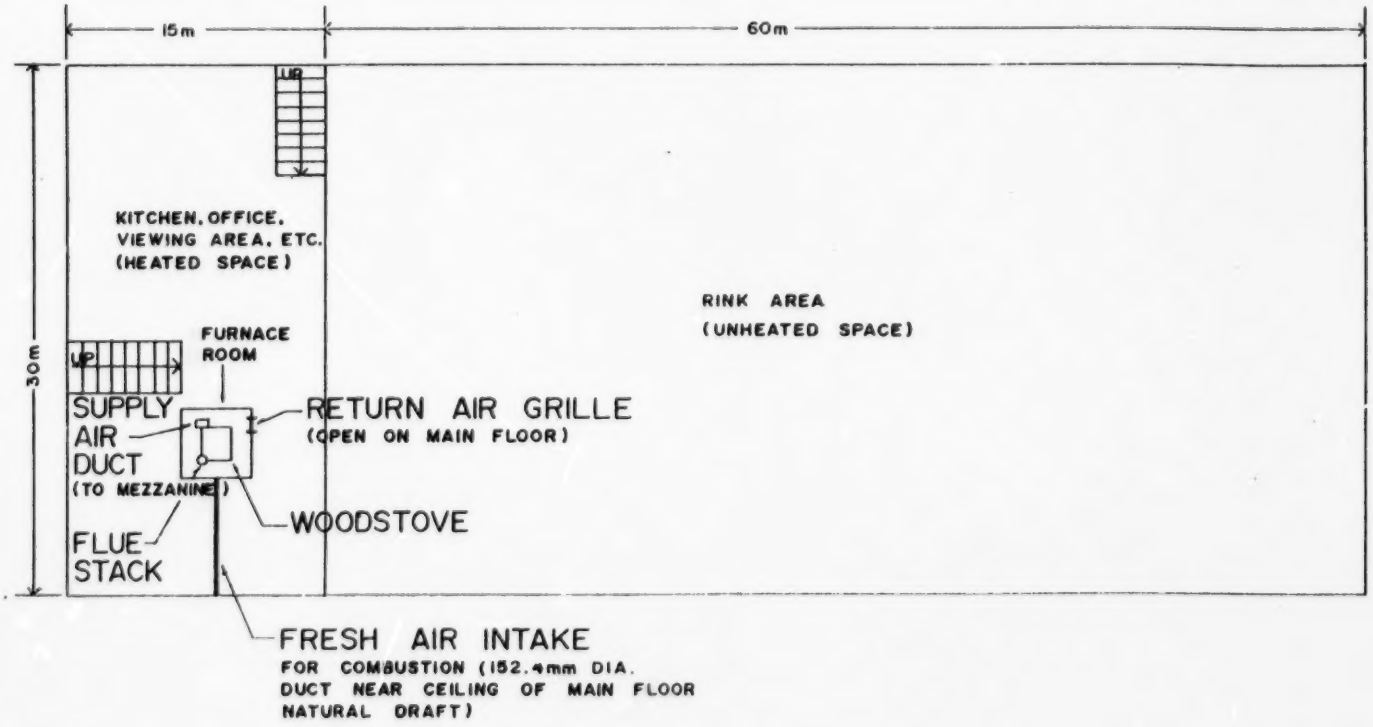
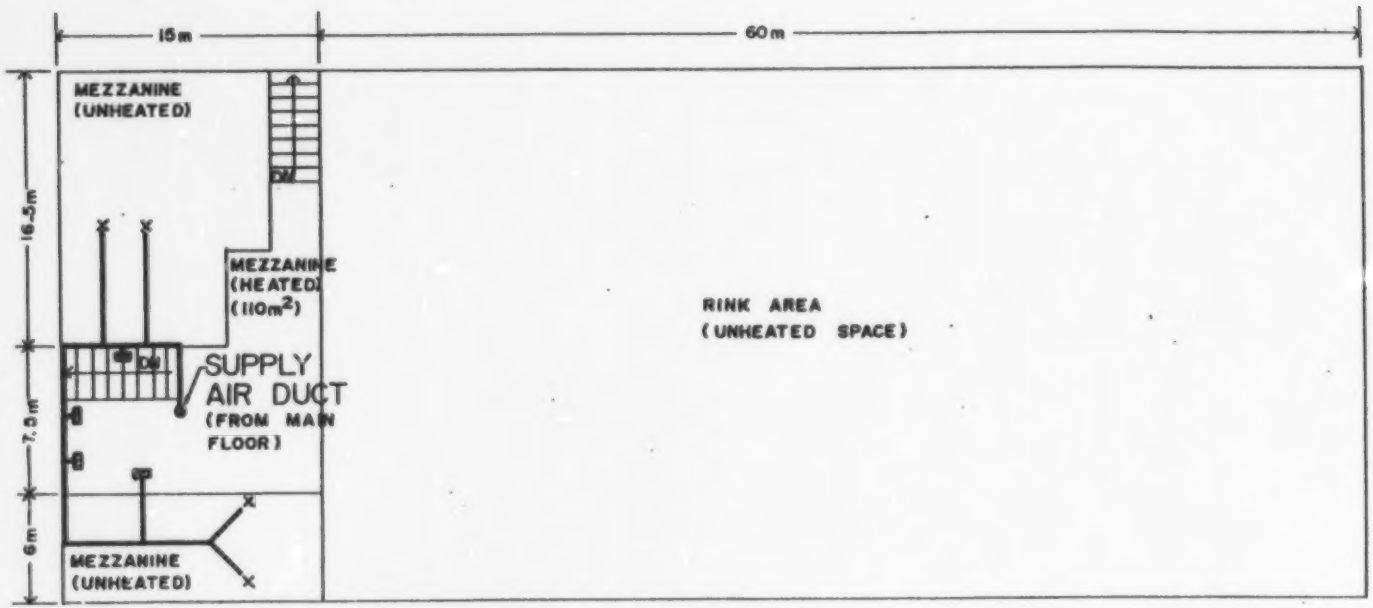


FIG. 2. PLAN VIEW OF ARENA WOODSTOVE HEATING SYSTEM ON MEZZANINE FLOOR.



NOTES

1. SUPPLY AIR DUCTS ARE LOCATED ON THE FLOOR OF THE MEZZANINE.
2. SUPPLY AIR DUCTS ARE INSULATED IN UNHEATED AREAS.

LEGEND

—— SUPPLY AIR DUCTS

× DIFFUSER INTO MAIN FLOOR

▨ DIFFUSER INTO MEZZANINE FLOOR

HEATING SYSTEM DESCRIPTION

The heated area in the Erickson Arena includes 450 square metres of ground floor and 110 square metres of mezzanine floor area as described in the previous Section. (See Fig. 1 & 2). The wood-burning furnace is the main heat source for the Arena. The heating system consists of the wood-burning furnace and forced-air electric unit heaters mounted on the ceiling. The unit heaters provide supplementary heat especially for periods of extremely cold weather.

The wood-burning furnace is composed of the following components:

1. The Stove - The stove is an R.S.F. Energy Woodstove (Model No. F200 Serial No. 820382) complete with a fire box, combustion air damper, and a Delhi 215 Fan. The size of the fire box is 0.9m x 0.6m x 1.0m and can safely hold 1/6 cord of wood. (1 cord = 1.2m x 1.2m x 2.4m). Combustion air is supplied from the outside through a 152.4mm diameter fresh-air duct and the combustion air damper. The fan, complete with a motor, functions as a blower to circulate warm air in the building.

The capacity of the stove is 200 000 Btu/hour. The stove is installed inside the furnace room which has an air grille on one of its walls for return air. The fan has an air circulation capacity of 2 800 cfm to 5 000 cfm for heat distribution.

2. The Chimney- The chimney, consisting of sections of metal flue stacks, ensures proper burning of the wood by pulling combustion air over the wood and exhausts combustion waste

products to the outside of the Arena.

The chimney is manufactured by Sentinel (ULC approved S629M). It is rated for temperature up to 1 200 degrees C. The installation of the chimney was inspected and approved by the Manitoba Department of Labour to be in conformance with all codes and regulations.

3. The Ductwork - The main ducts are made of galvanized sheet metal. Insulated plastic is used for branch ducts. The ductwork delivers warm air to the heated areas and maintains a uniform room temperature in these areas. The ducts are insulated whenever they pass through unheated areas. Warm room air is returned through the air grille on the wall of the furnace room for filtering and re-heating.

Fire dampers (or called firestops) are used in the ductwork between rooms. These fire dampers are spring loaded and are placed inside the ductwork. They are held open by fusible links. In case of fire, the heat will melt the link and the damper will close and shut off sections of ductwork. The fire damper thus localizes and retards the spread of fire.

4. The Fuel Supply- Poplar is used for fuel because it is the predominant species in the Erickson area. The Poplar is cut into 1.2m lengths, cured, stacked, and stored by the local volunteers for the year's supply of wood.

The operation of the wood-burning furnace is described in the next Section.

OPERATION OF THE WOOD-BURNING FURNACE

The operation of the wood-burning furnace is controlled by a room thermostat mounted close to the return air grille. When the room thermostat senses that heat is needed in the room, it sends a signal to the control system of the furnace which opens the combustion air damper on the stove. A hot fire develops as a result. When the air inside the furnace reaches 38 degrees C, the fan control starts the circulating blower. The blower circulates air through the stove at about 3 500 cfm. The air gains an average temperature of 10 degrees C passing through the stove. The warm air is then moved through the ductwork to the areas to be heated.

When the room thermostat senses that enough heat has been supplied, it sends a signal to the control system of the furnace which closes the combustion air damper on the stove. The blower continues operating until all the remaining heat has been removed from the stove.

In cold winter days, the stove at the Erickson Arena burns an average of one cord of Poplar wood per day. A cord measures 1.2m by 1.2m by 2.4m, and produces about 17 million Btu for air-dried Poplar.

The stove can hold about 1/6 cord of firewood and has to be fed with the firewood every 4 hours on a cold day. It takes about 10 minutes or less to feed the wood into the stove each time. The stove is fed once for the whole night prior to the closing of the Arena. The unit heaters are thus required to supplement the heating in cold weather.

DRAWBACKS OF SYSTEM

The wood-burning furnace has the following drawbacks compared to an electric or oil furnace:

1. It requires more manual labor to operate. Firewood has to be fed into and ashes have to be removed from the stove regularly.

2. It requires more maintenance. Due to the deposit build-up from burning wood, the chimney must be cleaned regularly to ensure long-term reliability and safety. The air filter must often be cleaned and replaced.

3. Its continued operation depends heavily on the continuous future supply of wood.

4. It requires storage space for the wood supply.

5. As a result of the above drawbacks 1 to 3, a wood-burning furnace is human-dependent for its basic operation and is less reliable than an electric or oil furnace.

SYSTEM AND ENERGY COSTS

The installed cost of the wood-burning furnace was $18 400. This includes labour and material described in the "Heating System Description" Section; that is: the stove, the chimney and associated ductwork. The capacity of the stove is 200 000 Btu/hour and it operates at an efficiency of about 45%, giving an available heat of 90 000 Btu/hour.

The heat loss of the heated area is estimated to be 86 160 Btu/hour when the outdoor temperature is 34 degrees C below zero and the room temperature is 21 degrees C. Therefore, the wood stove will be adequate to supply all the required heat except on extremely cold days. In an average year, the total heat required for the heating season is about 238 million Btu or 69 600 kwh. (based on the average daily temperature in Erickson and an annual total degree-days of 6389). At an electricity rate of 3.886 cents/kwh (6% provincial sales tax included), the cost of energy is $2 700 per year if electric heat is used. By using the stove, this amount of energy cost will be saved each year.

The capital cost of an alternative electric furnace for the Erickson Arena is about the same as the wood-burning furnace. Thus the wood-burning furnace is cheaper to operate than an electric furnace provided that:

1. The fuel cost is free for the wood-burning furnace. Vol-

unteer help is available and wood can be obtained without any cost.

2. Maintenance of wood-burning furnace will be performed by volunteers without any cost. (Maintenance of an electric furnace is negligible).

The estimated savings in 1985 will be $2 700, resulting from the savings in energy cost. This annual savings will vary from year to year depending on the escalation of electricity rate in future years. If we assume that the wood-burning furnace will last 20 years, the total savings in this time period will be $54 000. These savings are based on the assumptions that electricity cost and inflation will increase at the same rate. To calculate the savings at other rates, the present value factor shown in Table 1. can be used.

The simple payback period for the installation is calculated to be $18 400/$2 700 or 6.8 years.

RECOMMENDATIONS

Recommendations are made on both the operation of the Erickson Arena wood-burning furnace and future wood-burning furnace installations in other areas.

Operation

To ensure proper operation of the wood-burning furnace at the Erickson Arena:

1. Regular inspection of the chimney and maintenance of the furnace should be performed. A maintenance program should be implemented.
2. The temperature and carbon dioxide of the exhaust should be measured regularly to ensure that proper combustion is taking place in the stove. Adjustment to the system might have to be made to improve furnace efficiency and reduce creosote build-up inside the chimney.

Future Installations

The installation of a wood-burning furnace is viable if the criteria below are met:

1. Plentiful supply of wood is available at little or no cost.
2. The system is properly designed and installed. It is inspected and approved by the proper authority to verify conformance with all codes and local requirements.
3. Manpower is available, at no cost, to operate and maintain the furnace.

4. The building is at a remote location where the cost of electricity or oil is high.

Table 1. PRESENT VALUE FACTOR

The Present Value Factor below is used to convert the stream of future dollars to today's dollars.

Escalation Rate	10% Discount (d = .10)	9% Discount (d = .09)	8% Discount (d = .08)
d + .05	32.95	33.11	33.27
d + .02	24.30	24.34	24.39
d	20.00	20.00	20.00
d - .02	16.59	16.56	16.53
d - .03	15.15	15.11	15.08

Escalation Rate = Annual rate of increase in the price of specific goods and services. Inflation is the overall rate of price increase of goods and services in the economy. Escalation of fuel cost may be higher or lower than inflation in the short run, but escalation of fuel cost is expected to exceed inflation in the long run.

Discount Rate = Annual rate of return earned by an investment. This rate is used to convert future investment earnings to present dollars.

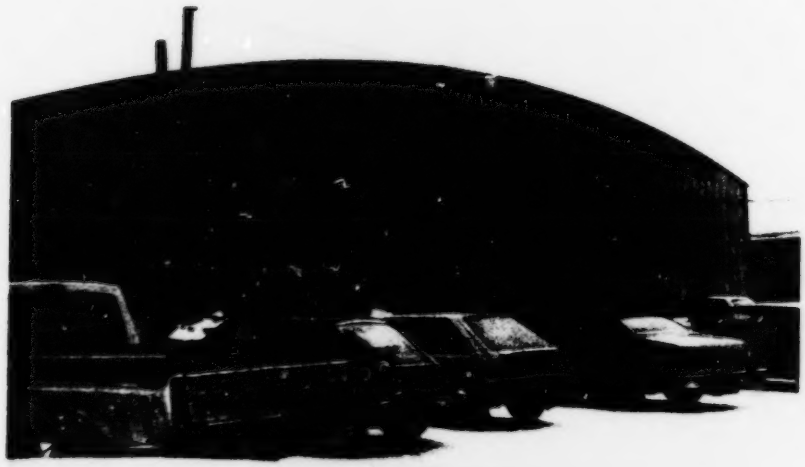


PHOTO 1. ERICKSON ARENA BUILDING

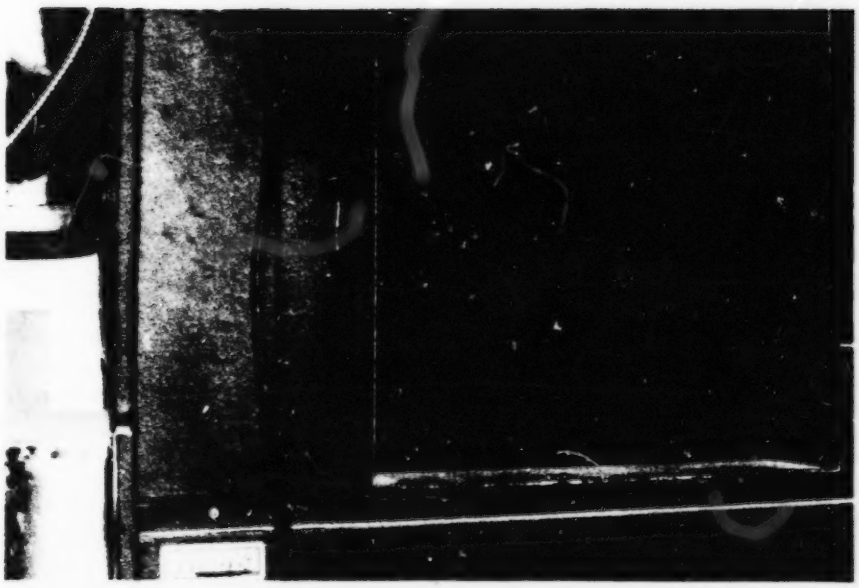


PHOTO 2. WOOD STOVE SHOWING FIRE BOX.

PHOTO 3. BLOWER FOR AIR SUPPLY.

PHOTO 4. FILTER SYSTEM FOR BLOWER.

PHOTO 5. SECTIONS OF CHIMNEY.

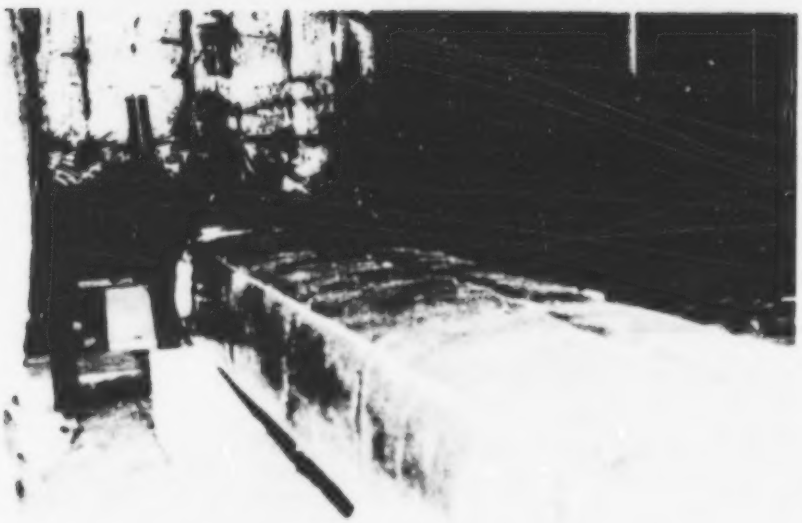


PHOTO 6. INSULATED MAIN DUCT.